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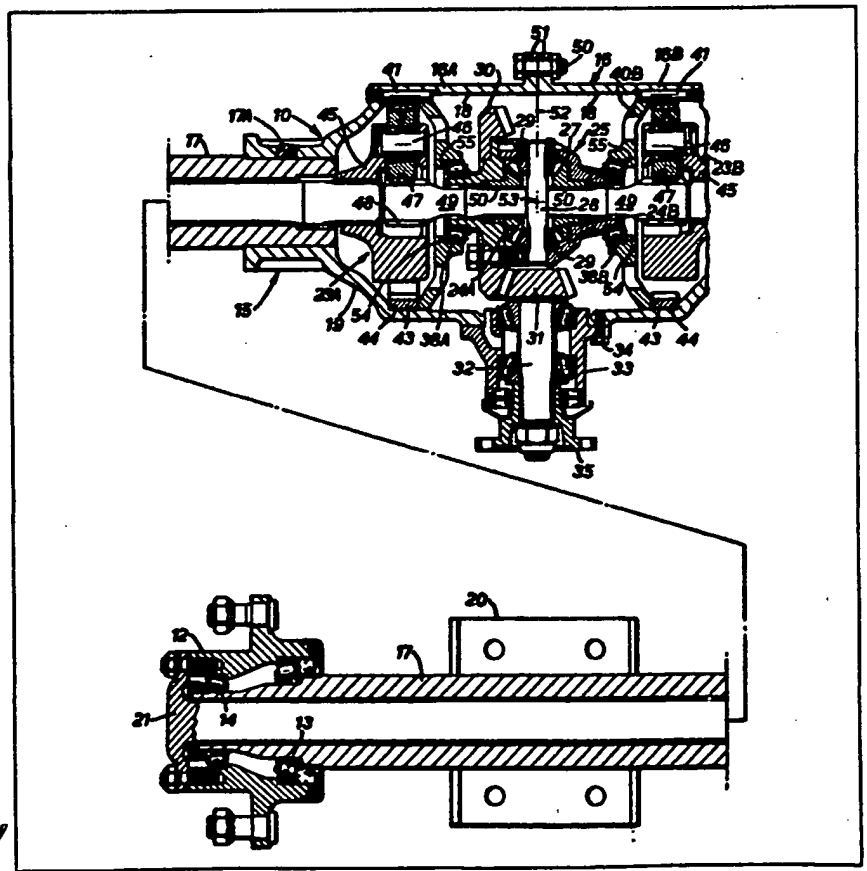
(71) Applicant
Newage Transmissions Limited
(United Kingdom)
Park Works
Barnack Road
Stamford PE9 2NB
Lincolnshire
(72) Inventor
George Smart
(74) Agent and/or Address for Service
Kilburn and Strode
30 John Street
London WC1N 2DD

(54) **Driven axles**

(57) A driven axle (10) for a land vehicle, the central portion (16) of whose casing houses a crown wheel (30) and pinion (31) forming a first reduction stage, a differential (25) and two epicyclic second stage reduction units (23A, 23B) whose planet carriers (45) are coupled to the two floating drive shafts. The cage (27) of the differential is journalled in bearings (38A, 38B) supported and located by respective dished annular supporting plates (40B) whose outer peripheries are an axially-sliding fit in the central casing portion (16) and are axially abutted against the annulus gears (43) of the epicyclic units (23A, 23B). The central casing portion (16) is formed of two identical sleeves (16A, 16B) clamped together axially by bolts (50) to preload the supporting plates (40B) in axial compression between steps (44) thus axially-preloading the differential cage bearings (38A, 38B). Shims (54) enable this preload to be adjusted.



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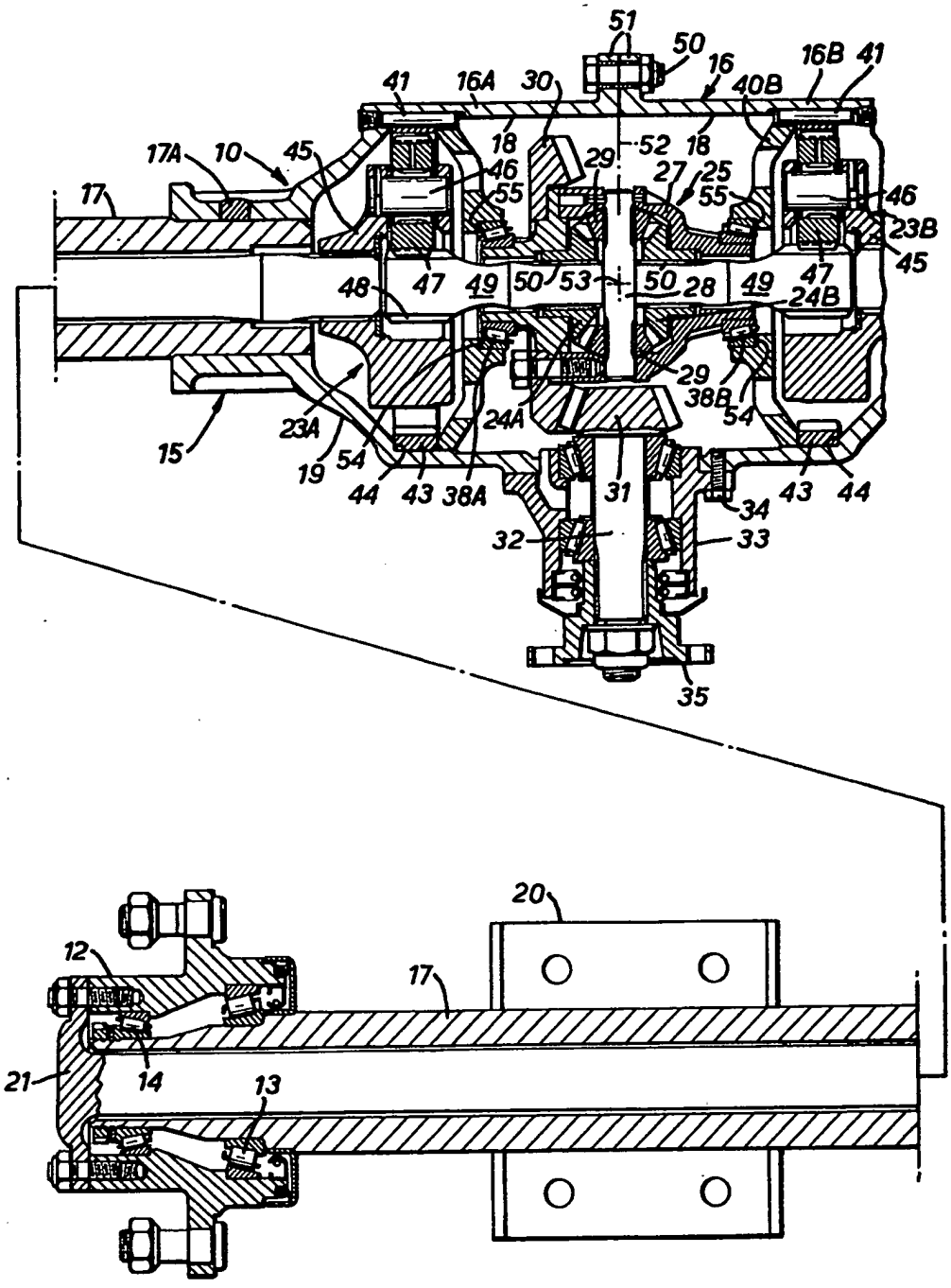
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SPECIFICATION

Axles

This invention relates to driven axles for land vehicles, of the type incorporating a differential gear mechanism for transmitting the drive of the vehicle propeller shaft, coupled to the axle input, through driving shafts to wheel hubs at opposite ends of the axle casing, with a double speed reduction between the input to the axle and the wheel hubs of which the first reduction stage is provided by a crown wheel and pinion gear assembly between the axle input and the differential cage, and the second reduction stage is provided by a separate secondary reduction gear mechanism associated with each of the driving shafts and housed within the axle casing.

The invention is concerned with improvements to the axle construction and to the assembly and location of the differential unit and secondary reduction units in the axle housing, to simplify manufacture and facilitate assembly.

The invention is particularly although not exclusively applicable to driven axles intended for use as the driven rear axle of a four-wheel drive vehicle whose front wheels are braked and whose rear wheels are not provided with wheel brakes.

According to the invention from one aspect in the axle of the type specified the differential unit is supported and located in a central portion of the axle casing by means of two annular supporting plates the inner peripheral portion of each of which supports one of the bearings of the differential cage in the central casing portion, the outer peripheral portion of each supporting plate being a sliding push-fit, in the axial direction, against an abutment in the central casing portion. In a preferred construction each annular supporting plate is abutted against one of the two secondary reduction units, the two supporting plates providing location in the axial direction for both secondary reduction units and the differential unit.

Where the secondary reduction units are of epicyclic type, as is preferred, the outer peripheral portions of the two supporting plates will bear against the annulus gear of the epicyclic unit, thus locating that gear and with it the planet carrier in the central casing portion.

To maintain the stability and rigidity of the complete assembly in the central casing portion, the bearings of the differential cage are axially-preloaded by the two supporting plates which are under axial compression between their outer and inner peripheral portions, this preloading being produced by axially clamping together two separate portions of the central casing portion of the axle in assembly.

According to the invention from another aspect, preferably but not necessarily associated with the aspects of the preceding paragraphs, the casing of an axle of the type specified includes a central portion which accommodates the differential unit and the first and second reduction stages and is an assembly of two identical sleeve portions abutted together, each sleeve portion providing half of the central portion. This facilitates manufacture, sine stock half-casing sleeve components can be made by repetition casting in a single mould, two of the identical sleeve components being utilised per axle.

The two half-casing sleeves may be abutted together with their abutted joint faces lying in a common transverse plane of symmetry of the central casing portion, passing through the centre of the differential unit.

The invention from yet another aspect comprises a casing for any kind of gear mechanism or gearbox, formed in two substantially identical halves abutted together, for example at a common planar joint face. The two halves may be substantially identical castings from the same mould.

The invention may be carried into practice in various ways, but one specific embodiment thereof will now be described by way of example only, and with reference to the accompanying drawing, which is a view in longitudinal section of the major part of the length of a rigid rear axle for a four-wheel-drive vehicle.

The illustrated axle 10 is intended for use as a rear axle of a four-wheel-drive land vehicle, for example a dumper truck, only the front wheels of which are braked. The axle 10 is of the fully-floating kind having a wheel hub 12 journalled on spaced wheel bearings 13, 14 on each end of the rigid axle casing 15. Only one of the wheel hubs 12 is shown in the drawing. The casing 15 comprises a mainly-cylindrical central casing portion 16 formed in two identical halves 16A and 16B, and two tubular side sleeves 17 (only one shown in the drawing) projecting in opposite directions from the central portion 16. Each of the identical halves 16A comprises a tubular sleeve having a cylindrical large-diameter portion 18 and a tapering outer end portion 19 in the bore of which the inner end of the generally-cylindrical side sleeve 17 is a press fit, with a security plug weld 17A. The wheel hubs 12 are journalled on the outer ends of the side sleeves 17, each of which is provided with a mounting bracket 20 for mounting the axle on the suspension or chassis of the vehicle.

Each of the wheel hubs 12 is driven by an associated drive shaft 20 extending in free-floating fashion within the respective side sleeve 17, each shaft 20 having an integral outer end flange 21 bolted to the wheel hub by bolts 22. The inner end of each drive shaft 20 is driven via a secondary reduction unit

23A or 23B from one of the output pinions 24A, 24B of a differential unit 25, the differential unit 25 and both secondary reduction units being housed in the central casing portion 16.

The differential unit 25 is of conventional form, comprising a cage 27 on whose planet-carrier spindles 28 (only one shown) two pairs of planet pinions 29 are journalled (only one pair shown), the planet pinions 29 being in permanent mesh with the two output pinions 24A and 24B. The cage 27 carries a crown wheel bevel gear 30 meshing with a bevel pinion 31 on the input shaft 32 of the axle unit, the crown wheel 30 and pinion 31 providing the primary speed reduction of the final drive through the axle. The input shaft 37 is journalled in an input housing member 33 bolted at 34 to the central housing portion 16 and carries a coupling flange 35 to which the propeller shaft of the vehicle can be attached.

The cage 27 of the differential unit is journalled in tapered roller bearings 38A, 38B the outer race of each of which is supported by the inner peripheral portion of a dished annular support plate 40A or 40B. The outer peripheral portion of each support plate 40A or 40B is a sliding push-fit in the interior of the cylindrical portion 18 of the respective half sleeve 16A or 16B of the central casing portion 16. Locating dowels 41 engaged in registering holes in the half-sleeves 16A, 16B and in the outer peripheral portions of the associated support plates 40A, 40B prevent rotation of the latter. The outer peripheral portion of each support plate 40A or 40B abuts, in the axial direction, against the annulus gear 43 of the associated epicyclic reduction unit 23A or 23B which is also a sliding push-fit in the cylindrical sleeve portion 18 and bears against a step 44 at the inner end of its tapering portion 19. Each epicyclic reduction unit 23A or 23B has a planet carrier 45 on whose planet pins 46 the planet pinions 47 are journalled in permanent mesh between the internal teeth of the annulus gear 43 and the external teeth of sun gear 48 formed on one end of a stub shaft 49, the other end of the stub shaft being spline-coupled at 50 to one of the output pinions 24A, 24B of the differential unit.

The two support plates 40A and 40B thus not only support the differential unit 25 radially in the bearings 38A, 38B but they also provide axial location for it and for the annulus gears and planetary assemblies of the two secondary reduction units 23A, 23B, holding the latter against the steps 44. Moreover, the tapered roller bearings 38A and 38B are preloaded in the inward axial directions, by virtue of the pre-compression of the two support plates 40A, 40B during assembly. This preloading is effected by the clamping together of the two casing half-sleeves 16A, 16B by means of clamping bolts 50 through their flanges 51, the joint faces of the flanges 51 lying in a common plane 52 passing through the centre 53 of the differential unit 25. The dimensions of the assembly between opposite steps 44 are such that when the bolts 50 are fully tightened the outer peripheral portions of the two support plates 40A, 40B are compressed towards one another with respect to their inner peripheral portions, thus preloading the outer races of the bearings 38A, 38B inwardly towards one another. The degree of this preloading, which may be adjusted for example by means of one or more suitable shims 54 interposed between the outer race of one or each differential cage bearing 38, 38A and a locating shoulder 55 of the respective support plate 40A, 40B, or in some other way, maintains the stability and rigidity of the complete central portion 16 of the axle and the mechanisms assembled in its interior. The amount of axial preload on the bearings, and the stiffness of the dished annular support plates 40A, 40B, are related, in the design of the axle, to the crown wheel 30 and pinion 31 tooth loads, to ensure their stability.

The overall step-down ratio of the final drive provided by the axle described and illustrated depends upon the application requirement, but in a typical example it may be 14.8:1, provided by a first stage reduction ratio of 2.64:1 at the crown wheel and pinion gearing 30, 31 and a second-stage reduction ratio of 5.6:1, provided by each epicyclic reduction unit 23A or 23B.

CLAIMS

1. A driven axle of the type specified for a land vehicle, in which the differential unit is supported and located in a central position of the axle casing by means of two annular supporting plates the inner peripheral portion of each of which supports one of the bearings of the differential cage in the central portion of the casing, the outer peripheral portion of each supporting plate being a sliding push-fit, in the axial direction, against an abutment in the central casing portion.

2. An axle as claimed in Claim 1, in which each annular supporting plate is abutted against one of the two secondary reduction units, the two supporting plates providing location in the axial direction for both secondary reduction units and the differential unit.

3. An axle as claimed in Claim 2, in which the secondary reduction units are of epicyclic type, and in which the outer peripheral portion of each of the two supporting plates bears against the annulus gear of the respective epicyclic unit, thus locating that gear and the planet carrier of the unit in the central casing portion.

4. An axle as claimed in any one of Claims 1 to 3, in which the bearings of the differential cage are axially-preloaded by the

two supporting plates which are under axial compression between their outer and inner peripheral portions, and in which the central casing portion is formed in two separate portions which are axially clamped together in assembly to produce the said preloading.

5. An axle as claimed in any one of the preceding claims, in which the central portion of the axle casing accommodates the first and second reduction stages of the axle as well as the differential unit, and comprises an assembly of two identical sleeve portions abutted together, each sleeve portion providing half of the central portion of the casing.

6. An axle as claimed in Claim 5, in which the two sleeve portions are abutted together with their abutted joint faces lying in a common transverse plane of symmetry of the central casing portion, the said plane passing through the centre of the differential unit.

7. An axle as claimed in Claim 5 or Claim 6, in which the two sleeve portions are substantially identical castings from the same mould.

8. An axle as claimed in any one of the preceding claims, in which each annular supporting plate is of dished form arranged with its outer peripheral portion axially-further from the central transverse plane of the axle than is its inner peripheral portion.

9. A driven axle of the type specified for a land vehicle, whose axle casing includes a central portion which accommodates the differential unit and the first and second reduction stages of the axle and is an assembly of two identical sleeve portions abutted together, each sleeve portion providing half of the central portion.

10. An axle as claimed in Claim 9, in which the two sleeve portions of the central casing portion are abutted together with their abutted joint faces lying in a common transverse plane of symmetry of the central casing portion, the said plane passing through the centre of the differential unit.

11. An axle as claimed in Claim 9 or Claim 10, in which the two sleeve portions are substantially identical castings from the same mould.

12. A casing for a gearbox or gear mechanism, formed in two substantially-identical halves abutted together.

13. A casing as claimed in Claim 12, whose said two halves are abutted at a common planar joint face.

14. A casing as claimed in Claim 12 or Claim 13, in which the said two halves are substantially-identical castings from the same mould.

15. A driven axle for a land vehicle, substantially as specifically described herein with reference to the accompanying drawing.

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